Improving Product Yield of OLEDs

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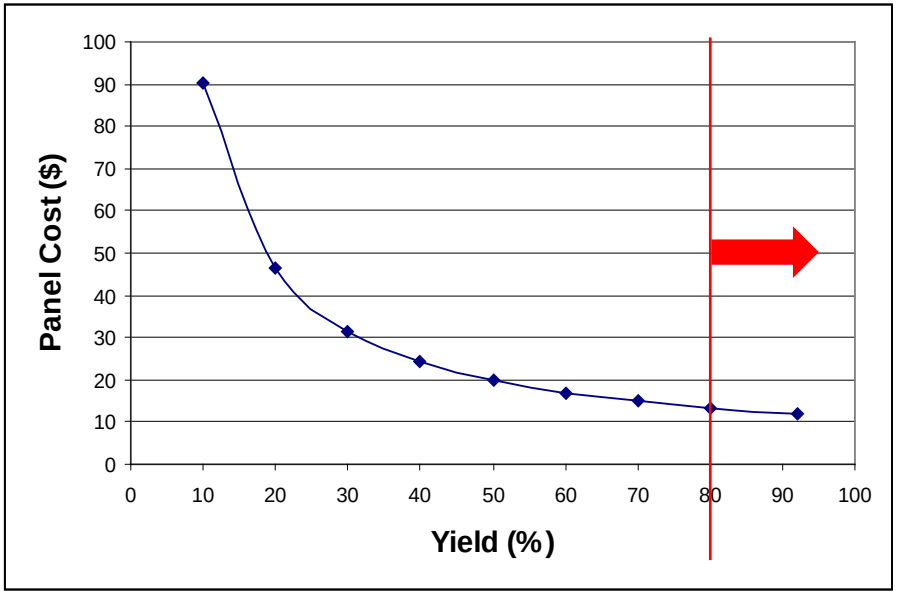
Technology Focus: OLED Manufacturing
Subtask Priority Area: M.O2. Manufacturing Processes and Yield Improvement

Project Objective

Reduce cost of OLED lighting through yield improvement:

- Improve manufacturing tolerances in both production equipment and processes
- Implement robust quality control methods and tools to reduce non-yielded products and minimize the need for binning



From July 2011 DOE SSL Manufacturing Roadmap:

Factor	Units	2012	2015	2020
Substrate area	m^2	0.17	0.67	1.95
Substrate utilization	%	70	80	80
Yield of good panels	%	75	90	95
Equipment uptime	%	50	75	90
Cycle time	s	120	30	20
Annual Production	1000 m^2	12	380	2100
Equipment cost	$M	60	150	250
Depreciation	$/$m^2$	1000	80	24

Target:
>80% yield by 2014
>90% yield by 2015

Yield

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Process Yield x Product Yield = Overall Yield

Process Yield

Target > 90%

- Broken/cracked panels
- Shorted panels
- Added defects – fails inspection
- Out-of-control, fails process specifications:
  - Glass cleanliness
  - ILE/ELE quality, uniformity
  - TCO thickness, Rs, %T, uniformity
  - Metal thickness, linewidth
  - Planarization quality
  - OLED deposition quality (thickness, composition, uniformity)
  - Encapsulation quality

Product Yield

Target > 90%

- Visual defects, darkspots, muras
- Back-end module assembly, electrical connection quality
- Out-of-spec performance – fails product specifications:
  - Color quality (CCT, duv, CRI)
  - Color/brightness uniformity
  - Efficacy
  - Lifetime (lumen/color maintenance)

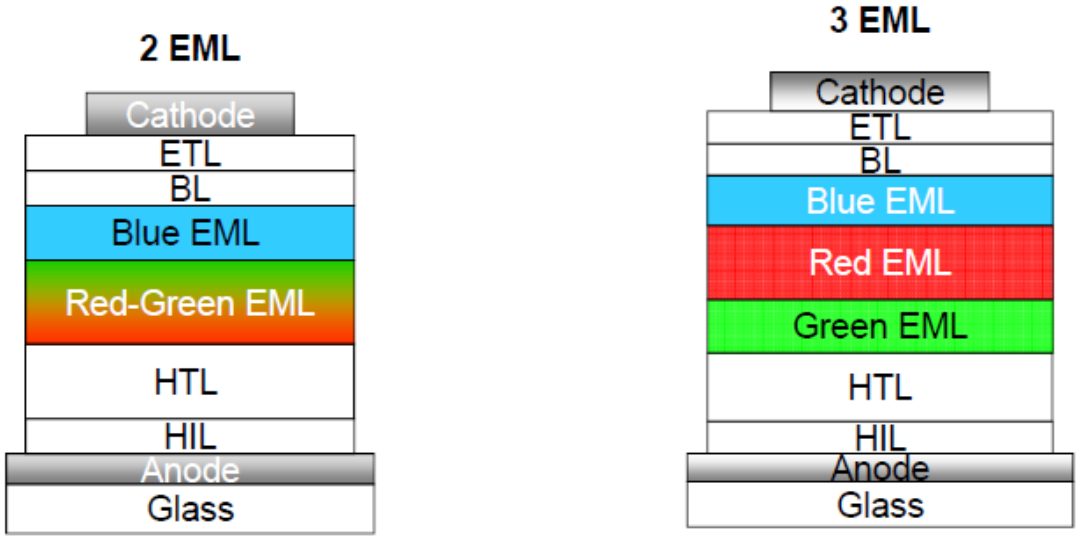
Yield depends on product specifications!

Overall Yield Target > 80%

(0.9 x 0.9 = 0.81)

Highlights

- In-depth studies performed on white OLED stack to understand effect of layer thickness and dopant % on white color; Improved process repeatability and control



• Less material used • Fewer process steps	**Advantages**	• Higher red dopant deposition rate • Process more repeatable
• Red dopant deposition rate is very low which may cause repeatability issues	**Disadvantages**	• Higher material usage • Longer TACT time

Highlights

- Defined key process variables for low cost integrated substrates
- Low cost integrated ELE performs well with white PHOLED